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ABSTRACT

Much literature on eating disorders has been published since the late 1970's but authorities still do not agree on terminology or diagnostic criteria. Suggested therapies have included group therapy, individual and family therapy, medical procedures, incorporation of an anxiety model, behavior therapy, and feminist therapy. Therapists need to evaluate the results of each type of therapy. An interrupted time-series analysis is used in this case study. The subject was a 22-year-old white female who described her problem as over-eating and binging. Cognitive behavioral therapy was used. Two variables were used in analysis: the number of meals per day and the number of meals per day preceded by an uncomfortable emotion. While the quantity of meals remained stable, the proportion of client-defined meals preceded by an uncomfortable emotion declined. Feedback graphs of eating behavior helped the client develop a more realistic idea of her eating behavior. Graphing client behavior can be useful for both the client and the therapist. (ABL)

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Time-Series Analysis of Therapeutic Process and Outcome: An Eating Disorder

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Abstract

A great deal of literature has been published in the past several years concerning eating disorders. In addition, a variety of etiological models and treatment strategies have been proposed with little empirical verification of outcome. In keeping with an ipsative or intraindividual research model, a single-subject design was used to evaluate process and outcome with the treatment of a young female adult who presented an "eating problem."

Two variables, the number of "meals" per day and the antecedent affect, were recorded by the client for 99 days. Computer generated graphs of antecedent affect were used during each therapy session as a feedback tool for both the therapist and the client. Interrupted time-series analysis (Box & Jenkins, 1976) was used to assess the client's behavioral patterns. The client significantly reduced her negative affective disturbances before "meals" and her concomitant negative self-perceptions while her "meal" rate remained constant. Other qualitative changes in the client's behavior are discussed and advantages of using an interrupted time-series analysis are presented.

Time-Series Analysis of Therapeutic Process and Outcome: An Eating Disorder

Eating disorders have become the treatment dilemma of the 80's for both the client and the clinician. Even a cursory search of the literature reveals numerous articles on the subject with the total number increasing yearly from the late '70's through the mid-'80's. In fact, between late 1978 and early 1984, 35 books were published on the subject of anorexia and bulimia alone, far more than the number of books published on solving the problem of world hunger, a total of 14 during the same time period.

Even with the abundance of literature available, authorities still do not agree on terminology, let alone on diagnostic criteria. As a result, some writers use the term "anoxeria nervosa" and "bulimia" (Pope, Hudson, & Yurgelun-Todd, 1984); others use "binge eaters and purgers" (Cullari & Redman, 1984); others prefer "binge-eating and vomiting" (Carter & Duncan, 1984); others like "bulimia nervosa" (Leitenberg, Gross, Peterson, & Rosen, 1984); and still others cover more bases by using the terms "bulimia, bulimarexia, and bulimia nervosa" (Nagelberg, 1984). Although some writers (Cullari & Redmon, 1983) have argued that "bulimia" and "bulimarexia" are not equivalent terms, others (Nagelberg, 1984; Fairburn & Cooper, 1983) have emphasized that the two syndromes do refer to the same clinical phenomenon. In fact, Nagelberg (1984) expressed the hope that clinicians and researchers would "not be confused by the variety of labels applied to what appears to be the same clinical syndrome: bulimia = bulimarexia = bulimia nervosa." (p. 476)

The confusion over labels certainly has not prevented a proliferation of literature. Almost all branches of the helping professions reflect a concern about eating disorders through articles in their professional journals. School psychologists (Carter & Duncan, 1984; Peters, Butterfield, & McKay, 1984), psychiatrists (Stern, et al., 1984) nurses (Kagan & Squires, 1984), clinicians (Nagelberg, Hale, & Ware, 1984), and feminist therapists (Smead, 1984), among other types of professionals, have all been presented with articles in their professional journals on identification of bulimia. A variety of treatment strategies has been suggested, including group therapy (Stevens & Salisbury, 1984), individual and family therapy (White, 1984), medical procedures (Krahn & Mitchell, 1984), incorporation of an anxiety model (Leitenberg, Gross, Peterson, & Rosen, 1984), behavior therapy (Fodor & Thal, 1984), and feminist therapy (Brown, 1985).

Needless to say, the individual therapist may be overwhelmed by the amount of material available and the conflicting results from different treatment modalities presented in the literature. In addition, therapists may not be sure how to evaluate whether the treatment used was successful. Among others, Lazarus (1981) has advocated an ipsative approach or "clinical method" for studying client change. He has argued for the use of naturalistic observation in diverse situations over time to uncover changes in the pattern of the individual's responses to the environment. Interrupted time-series analysis has been shown to be an excellent research design for this purpose.

The following case study presents not only treatment strategies but a methodology for evaluating the effects of treament. Such a methodology, interrupted time series analysis, is appropriate for single subject analysis regardless of the theoretical approach or treatment strategy used by the individual therapist.

Therapeutic Strategies

The subject, Teri, a twenty-two-year old white female presented her main problem as "over-eating" and "bingeing." She saw her eating as a habit and as her major coping mechanism. She indicated she used diet pills and that nothing in the context of eating satisfied her. She also viewed her eating as compensation for an unmet need, "love."

During the nine weeks of therapeutic intervention the therapist, also the primary author, used a cognitive behavioral approach. Teri was asked to identify specific behaviors and thoughts surrounding food and to chart those behaviors and thoughts as well as the quantities of food eaten. Data were collected for a 36-day baseline and a 63-day intervention period. The cues Teri used to determine underweight, overweight, and onweight were evaluated as well as the "unmet need" she thought food was replacing. The social consequences, both rewards and punishments, for gaining and losing weight were discussed. Teri concluded much of her eating was a result of anger she was unwilling to discuss, particularly anger concerning the dependent-independent continuum. Bibliotherapy was suggested as a follow-up to treatment when Teri moved from the community.

Throughout treatment the therapist was able to monitor Teri's progress by applying an interrupted time series analysis to the data. In addition, the information was shared with Teri to facilitate her self-monitoring of behavior change.

Results

Because Teri's presenting problem was "over-eating," the therapist chose to focus upon this particular aspect of her behavior for analysis, selecting two specific variables to scrutinize. One measure, the reported number of meals per day, is shown in Figure 1. The second variable, a created variable, was the proportion of meals preceded by an uncomfortable emotion as defined by the client to the total meals consumed that day. These data are presented in Figure 2. It is important to note that the term "meal" was defined by the client and ranged from a few chips with salsa at one extreme to popcorn, crackers, cookies, ice cream, a baked potato, a chocolate heart, and a bag of potato chips (Valentine's Day dinner) at the other extreme. The correlation between the two variables under study is .243, p =.01.

The therapist searched for any autoregressive, integrated, or moving average (ARIMA) processes in the reported meals data that could bias test statistics (Box & Jenkins, 1976). The autocorrelation function, the degree of predictability between time-points, was generated in the form of a correlogram for both baseline and intervention data. The pre-intervention and intervention correlograms were averaged (see Table 1) for ARIMA model identification. The reported meals data appeared to possess an AR(1) or first-order autoregressive process.

Next, the independent variable, treatment effect (a dummy variable), was formulated to mirror the impact of treatment with Teri. The authors believed that the traditional change-in-level comparison between pre-treatment and treatment conditions was an inappropriate treatment impact model to examine behavioral change. Thus a treatment effect model or transfer function was generated which reflected the constant, gradual change that was expected from the therapeutic process. Baseline measurements were coded as "0". Treatment measures were coded incrementally as a linear function of time which eventually reached a full treatment effect coded as "1" -- i.e., [.016, .032, .048 ..., .968, .984, 1]. In addition, the therapist included the representation of an exogenous variable, Teri's 10-day visit to her parents' home during spring break, to model the intrusive, albiet short-lived, change in her environment. To accommodate the event mathematically, .6 was added to the occurrences of the independent variable which coincided with her visit. This figure was estimated to reflect the subjective change in life-style which Teri reported.

For the least-squares analysis of the reported meals data which included a first-order autoregressive process, a phi coeficient had to be estimated and included to reflect the underlying stochastic process. The maximum likelihood estimate of phi is approximately .22 and was determined via a reiterative approach described by Glass, Willson, and Gottman (1975). For this value of phi, the estimated level of the series at "time-point 0" is 4.33, $t(97) = 21.36$, $p < .01$, and the estimated intervention effect is -0.45, $t(97) = -1.05$, $p > .05$. To confirm the goodness-of-fit of the model, the Q statistic (Box & Jenkins, 1976) was used to simultaneously examine 10 lags of the regression residuals for autocorrelation. No significant autocorrelation was present, $Q(9) = 3.72$, $p > .05$. Thus, no significant change occurred over time in the number of meals consumed per day by Teri.

A similar procedure was followed for analysis of the second variable, proportion of meals preceded by an uncomfortable emotion. The baseline and treatment condition correlograms were not averaged (see Table 2), however, due to the presence of a deterministic trend in the intervention data. Differencing of the data removed the trend and revealed an AR(1) process acting on the data. The deterministic drift of the intervention series, the authors reasoned, ought to be accounted for by the independent variable, treatment effect. The maximum likelihood estimate of phi is .20 and for that value of phi, the estimated location of the series at "time-point 0" is 76.45 $t(97) = 19.60$, $p < .05$. More importantly, the estimated impact of treatment is -38.40, $t(97) = -4.73$, $p < .05$. No significant autocorrelation was present in the regression residuals, $Q(14) = 3.45$, $p > .05$. Thus, Teri reduced her mealtime antecedent negative affect by one-half over a 9-week treatment period.

Discussion

Overall, one of the measured variables, quantity of "meals," remained stable. On the variable, proportion of client defined meals preceded by "uncomfortable" affect, a pattern of gradual change was observed. In other words, the habit of eating did not change, but the client's affect and cognitions before and after eating did change. Teri herself reported that her cues for determining self-evaluation regarding her own weight also changed. The therapist's impression was that Teri's choices of food also changed from typically "junk food" to a more balanced diet.

Although only two variables were evaluated via ITSA, Teri indicated other positive aspects of the therpeutic process. In particular, she seemed pleased with improved interpersonal relationship skills. Rather than not recognizing her anger and avoiding uncomfortable discussions, she was more willing to confront conflict. Teri also admitted considerable anxiety regarding her upcoming relocation to a distant state after graduation. The recognition of her anxiety was new behavior for Teri. Even though she was afraid of leaving her friends, she chose to work through her anxiety herself instead of rushing to a friend for support or inviting a friend to go with her in search of a career.

The feedback graphs of her eating behaviors were particulary facilitative for Teri's developing a more realistic data base. For example, after returning from spring break, Teri reported that she has done "much worse" in her eating habits. After the therapist graphed Teri's eating behaviors, it was apparent that she was unaware of her actual behavior. In other words, while experiencing an increase in positive affect surrounding her meals, Teri's overall impresssion was an increase in negative experiences. By using the feedback graphs, Teri was able to realign her perceptions to more closely represent her experiences. The therapist also was able to get immediate feedback from the graphs regarding Teri's progress.

Unfortunately, Teri moved from the area and there was no way to determine whether her changed perceptions regarding eating were maintained. The therapist hoped that through suggested readings Teri would find the necessary support to continue on a similar course.

Graphing client behavior can have enlightening and reinforcing aspects for both the therapist and the client. In addition, by working together on the feedback process, the client can benefit from the increased sense of responsibility for his or her own therpay. However, it may be tempting for the therapist to quickly "eyeball" the graphed data and interpret results to the client; such a temptation should be avoided. Although the use of interrupted time-series analysis requires a more methodical approach than visual analysis, underlying stochastic processes which can mask or exaggerate intervention effects will be uncovered and interpretations will be more accurate.

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Table 1

Autocorrelation Coefficients and Standard Errors

For Variable 1

	Baseline-Intervention Averages			
	Differencing = 0		Differencing = 1	
Lag	ACF	Std. Error	ACF	Std. Error
1	.22*	.20	-.33*	.20
2	.03	.21	-.03	.22
3	-.17	.21	-.18	.22
4	-.06	.21	.04	.22
5	-.05	.21	.03	.22
6	-.07	.21	-.13	.22
7	.06	.21	.16	.23
8	-.04	.21	-.08	.23
9	.02	.21	.05	.23
10	-.02	.21	-.06	.23
11	.05	.21	.07	.23
12	-.05	.22	-.03	.23
13	-.10	.22	.02	.23
14	-.12	.22	-.11	.23
15	-.04	.22	.10	.24

*$p < .05$

Table 2

Autocorrelation Coefficients and Standard Errors

For Variable 2

	Baseline		Intervention		Intervention: Differencing = 1	
Lag	ACF	Std. Error	ACF	Std. Error	ACF	Std. Error
1	.21	.16	.40*	.12	-.47*	.25
2	.06	.17	.36*	.14	.17	.30
3	-.17	.17	.10	.15	-.19	.31
4	-.13	.18	.12	.16	.06	.32
5	-.07	.18	.10	.16	-.05	.32
6	.14	.18	.13	.16	.04	.32
7	.04	.18	.12	.16	.03	.32
8	.23	.19	.06	.16	.03	.32
9	.00	.19	-.02	.16	.00	.32
10	.25	.19	-.12	.16	-.11	.32
11	.09	.20	-.06	.17	.14	.32
12	-.03	.20	-.19	.17	-.28	.33
13	-.13	.20	.04	.17	.23	.34
14	-.19	.20	-.02	.17	-.05	.35
15	-.17	.21	-.02	.17	.07	.35

*$p < .05$

Figure 1
Number of client-defined meals consumed per day

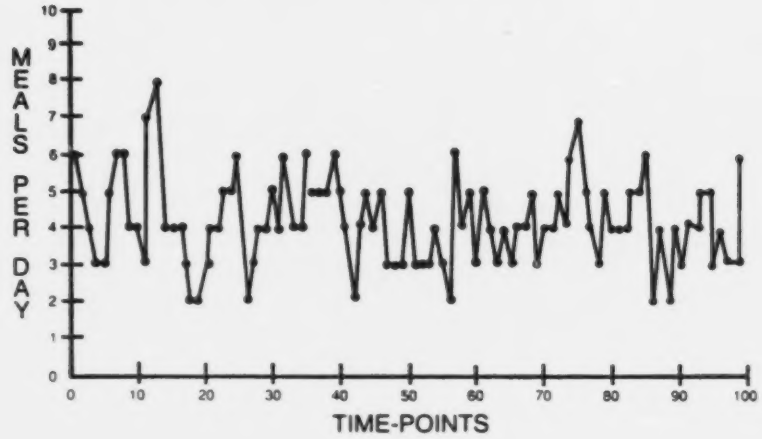

Figure 2
Proportion of daily meals preceded by aversive affect